FINAL REVIEW DRAFT

Task 1: Urban Stormwater Runoff Preliminary Needs Assessment Technical Memorandum

Prepared for

The Puget Sound Partnership

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ACRONYMS AND ABBREVIATIONS

AKART	all known, available, and reasonable methods of prevention, control, and treatment
BMP	best management practice
cfs	cubic feet per second
CWA	Clean Water Act
EBI	Environmental Behavior Index
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FY	fiscal year
LID	Low Impact Development
M&O	maintenance and operation
MEP	maximum extent practicable
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PAH	polycyclic aromatic hydrocarbon
PBDE	polybrominated diphenyl ethers
PIC	pollution identification and correction
ppm	parts per million
PSP	Puget Sound Partnership
RCW	Revised Code of Washington
TMDL	total maximum daily load
TPH	total petroleum hydrocarbons
TSS	total suspended solids
VMT	vehicle miles traveled
WRIA	Water Resource Inventory Area
WRR	Waste Reduction and Recycling
WSDOT	Washington State Department of Transportation

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Those participating in the study did so in the hope that finally, permanent solutions will be funded to correct problems with stormwater that has been long in the making. The authors throughout this work were impressed with the commitment of each participant to the goal of improving stormwater and protecting Puget Sound; they just need the resources and support to do so. The authors hope that sufficient information is contained herein, along with other work led by the Partnership and Ecology, to achieve a permanent, ongoing funded program that will protect Puget Sound.

EXECUTIVE SUMMARY

The Puget Sound Partnership Action Agenda of May 2009 states: "Surface water and stormwater runoff in urban and rural areas are the primary transporters of toxic, nutrient, and pathogen pollutants to surface and groundwater resources throughout the Puget Sound basin." Three out of the top four priorities in the Action Agenda for reducing sources of water pollution involve stormwater runoff. Yet, a complete assessment of the financial investment required to reduce stormwater pollutant degradation of Puget Sound has not been done to date. This technical memorandum for the Puget Sound Partnership is a preliminary attempt on a coarse scale to quantify two components of urban stormwater pollution control: (1) the needs of cities and counties to fully implement the Municipal National Pollutant Discharge Elimination System (NPDES) Phase I and Phase II permit programs, and (2) the need for stormwater retrofits. The intended audiences are policy makers at the federal, state, and local levels. The key "take away" points from this work are:

- Puget Sound permittees invested between $160 million to $170 million in 2009 to implement the NPDES municipal stormwater permits, which represent a significant portion of the total amount they spend on overall stormwater control.
- This investment removed 234,000 tons of contaminated sediment that did not reach Puget Sound or its tributary watersheds
- The costs of retrofitting impervious surfaces developed prior to stormwater quality controls in the Puget Sound basin range from $3 billion to $16 billion depending on how the work is prioritized

It is important to keep in mind that this report provides coarse, conservative estimates for the Puget Sound basin only. Moreover, the NPDES municipal stormwater permits are focused largely in urban areas. Stormwater runoff remains largely unaddressed for much of the ex-urban and rural Puget Sound landscape.

The Clean Water Act, first adopted in 1972, sets the policy and regulatory framework for stormwater pollution control in the nation. The NPDES permit is the primary instrument to control urban stormwater. The Washington State Department of Ecology (Ecology) issues municipal, industrial, and construction permits as the primary method of regulating stormwater. Permits for municipal separate storm sewer systems (MS4s) cover about half of the Puget Sound basin geographically through the Phase I permit for large systems (5 largest cities and counties) and the Phase II permit for small systems (76 permittees). The Phase I permit includes requirements for maintaining existing systems, the approval of new systems, inspections of potentially polluting land uses, investigations of illicit connections and enforcement, public education programs, retrofit planning, and monitoring activities. The Phase II permit does not include requirements for inspections of potentially polluting land uses, retrofit planning, and monitoring activities.

Twenty permittees (5 Phase Is and 15 Phase IIs) voluntarily provided data for this study, which were used to extrapolate to the remainder of the permittees within the Puget Sound basin. Permittees invested between $160 to $170 million in 2009 when implementing their permits at an estimated average cost of $40 per capita/year. This estimate is conservative (i.e. low) because many Phase II permittees are still ramping into their programs. It is also conservative because property and other stormwater related capital costs are not included. This level of investment represents from 50 to 80 percent of the total annual local investments in stormwater. The remainder is invested in drainage controls to reduce or prevent flood damage.

Phase I permittees were further able to provide an estimate of costs spent on stormwater system cleaning, and the approximate amount of material (total solids) removed by these practices (234,000 tons in 2009). Solids were used as a surrogate metric for estimating pollutant loadings and reductions to Puget Sound. The polluting potential of solids is qualitatively linked to other pollutants of concern (nutrients, pathogens, and toxic compounds) showing that solids reduction is an effective strategy for reducing pollutant loads.

The permittees reported large legacy loads of sediment (i.e. solids that have accumulated over years) as a result of past underfunded maintenance of transportation and associated stormwater systems. Based on limited data from some of the Phase I permittees, removing the legacy load would require their current maintenance budgets to be doubled or tripled, or about an additional $60 to $120 million annually over 5 years for all the permittees throughout Puget Sound. The City of Tacoma's experience on the Thea Foss and Wheeler-Osgood Waterways are good demonstrations of the value of such a program.

The permittees were able to demonstrate that without retrofits, the removal cost per ton of contaminated solids from the urban stormwater system is currently an effective tool for reducing pollutant loads from existing systems largely designed and built without water quality features. Inasmuch as these systems are not funded for retrofits in most cases, accelerating M&O programs that remove contaminated sediment may be the most immediate, cost effective and direct measure to remove pollutant loads from stormwater to Puget Sound until retrofits and source control programs are fully implemented.

Permittees also reported that additional resources are needed to complete 100 percent of source control inspections and illicit discharge investigations, and to strengthen enforcement capability. Based on limited data from the permittees, additional funding of $11 to $18 million annually is a conservative estimate of resources needed to achieve 100 percent inspections and 85 percent compliance throughout the Puget Sound basin, within 5 years.

The Stormwater Work Group on Monitoring estimates that the 5-year cost of a regional stormwater monitoring program ranges from $42 to $73 million with permittees contributing from $45 to $50 million. A separate body of work lead by Ecology is addressing low impact development (LID) standards for new and re- development The results of the LID work was not available at this writing.

State and federal programs have provided some resources to date to assist in implementation of the existing MS4 permit programs but the amount, while helpful, is about 6 percent of the current annual funding needed for the Phase II permittees.

Two state departments (Ecology and Washington State Department of Transportation) report their own needs to implement NPDES permits programs as $11 million and $22 million, respectively. As the permits administrator, Ecology has the responsibility to oversee the issuance of the permits and related processes and resource materials that support them, receipt and review of the reporting of permit compliance including evaluation of the monitoring data, enforcement of referred violations by the permittees and related duties. For Ecology, permittees include not only municipal agencies, but also industrial and construction permittees. The State Department of Transportation is a permittee and needs resources to undertake programs similar to those of the municipal permittees on their vast transportation infrastructure statewide. Both these agencies report that about 70% of their NPDES programs are within the Puget Sound basin.

The MS4 permits for the Phase I permittees require they plan for retrofits for stormwater facilities but do not require a funding level. Phase II permittees do not yet have a retrofit planning requirement. Most of the development that exists in the Puget Sound basin occurred prior to the adoption of the Ecology 1992 Stormwater Management Manual, which is presumed to be lacking water pollution control features. While optimally maintaining existing facilities and controlling new development can prevent pollutant loads from increasing, they cannot by themselves reverse the current pollutant loadings from untreated stormwater.

To assess the need for retrofits, geographic information system (GIS) data sets for 1996 and 2006 were compared for the Puget Sound basin to estimate 0 to 19 percent, 20 to 49 percent, 50 to 79 percent, and 80 to 100 percent impervious acreage [please refer to the body of the report for references and citations]. Impervious areas as of 1996 were presumed to be without water pollution controls. Thirteen best management practices for retrofits, without allowance for land acquisition due to high site-specific variability, were applied to these acreages, averaged, and estimates of capital and maintenance costs were developed. Table ES-1 summarizes the results of this effort. The costs are conservative (i.e. low) because they do not include land acquisition and full flow controls costs

Table ES-1. Increasing Level of Potential Average Capital Investment to Retrofit Land from Most to Least Impervious

Range of Imperviousness Addressed	80-100%	50-100%	20-100%	0-100%
Acres with Impervious Area Addressed	60,206	162,201	282,663	319,409
Potential Capital Investment *(Average of Low and High Estimate in Appendix A, Table 12)*	$3,010M	$8,110M	$14,133M	$15,645M
Potential Annual Maintenance Investment *(Average of Low and High Estimate in Appendix A, Table 1-2)*	$111M	$300M	$523M	$561M

Using literature values, solids loadings from retrofit implementation were also estimated. Values for retrofits costs and solids load reductions are reported both on a county and Water Resource Inventory Area (WRIA) basis for the Puget Sound basin. The impervious area estimates include both public and private properties. Based on road area data from two counties, adjusted slightly upward for public buildings, roughly half of the impervious acres are estimated to be public. If only these public areas were to be funded for retrofit, the cost would be about half of what is included in Table ES-1. However, land acquisition will increase these costs.

Given the level of investment that could be made in retrofits, prioritization is necessary. Options to prioritize retrofits are included in the recent MS4 Permit Improvement Guide completed by the U.S. Environmental Protection Agency in April 2010; a watershed characterization methodology being developed by Ecology; in-progress studies in the Juanita and WRIA 9 watersheds, and the re-activation and funding of Section 208 Plans under the Clean Water Act.

Acceleration of the maintenance, inspection, and pollutant source investigation elements of the MS4 permit program, in combination with addressing the highest priority retrofits, is recommended as the best catalyst for a significant recovery action in the Puget Sound basin by 2020 due to urban stormwater impacts from existing development.

1. INTRODUCTION

The Puget Sound Partnership (PSP) Action Agenda of May 2009 states: "Surface water and stormwater runoff in urban and rural areas are the primary transporters of toxic, nutrient, and pathogen pollutants to surface and groundwater resources throughout the Puget Sound basin." Three out of the top four priorities in the Action Agenda for reducing sources of water pollution involve stormwater runoff. Much has been written about storm and surface water, and how human activities change its natural quality and hydrologic character. Rather than repeat this discussion herein, the reader is referred to the many policy and scientific papers on the subject starting with the references list in the PSP Action Agenda (2009) and the PSP State of the Sound (2010) reports.

A complete assessment of the financial investment required to reduce such stormwater degradation has not been done to date. Task 1 is a preliminary attempt on a coarse scale to quantify two components of urban stormwater: (1) the need for stormwater retrofits, and (2) the needs of cities, counties, and the Washington State Department of Ecology (Ecology) to fully implement the Municipal National Pollutant Discharge Elimination System (NPDES) Phase I and Phase II permit programs. The intended audiences are policy makers at the federal, state, and local levels.

2. SCOPE OF TASK

The stormwater system is an open pathway or conveyance for pollutants from all landscapes: pervious and impervious, urban and rural, surface and groundwater. For a good definition of stormwater, see the Draft Stormwater Monitoring and Assessment Strategy for the Puget Sound Region, Volume 1: Scientific Framework and Volume 2: Implementation Plan (Puget Sound Stormwater Work Group 2010). Unlike a separated wastewater system, which is closed and sources of pollution identified and regulated as “point sources,” the stormwater system is open to the entire landscape, carrying pollutants from street and building surfaces, failed septic tanks, leaky sewers, landscape and agricultural products such as fertilizers and pesticides, spills, construction erosion, illicit connections, and air pollution. In most cases, these pollutant inputs to stormwater are neither identified nor regulated, hence the term “non-point source” of pollution.

Urban stormwater is in a separate class inasmuch as it has characteristics of both “point” (an end-of-pipe discharge) and “non-point” sources (open system). The Clean Water Act (CWA) deems urban stormwater a “point source” and regulates it through the NPDES permit program or NPDES permit. It is the urban part of the stormwater mosaic that is the focus of this task. This task is further limited to municipal urban stormwater regulated by the NPDES permit program, sometimes termed the Municipal Separate Storm Sewer System, or MS4 program. Much of the information herein was provided by individual Phase I and Phase II NPDES permittees. It does not include industrial, construction, or combined sewer permit programs. A subsequent phase is intended to address these additional NPDES programs and stormwater pollution from non-point sources.

This work attempts to assess the need for added investments to improve municipal urban stormwater quality controls. This assessment was done by developing coarse metrics on the costs and pollutant load reductions of the urban stormwater programs currently implemented, or being considered for implementation, in the Puget Sound basin. These programs are the municipal MS4 NPDES permit program and, as yet, loosely identified stormwater retrofit program. Finally, the scope of this work does not duplicate that being accomplished by other studies such as the Ecology lead LID work group, and the Stormwater Monitoring Work Group.

3. STORMWATER AS AN OPEN POLLUTANT PATHWAY

The purpose of the CWA is to "…restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Since its initial adoption in 1972, this Act has driven investments and regulations to improve the quality of water nationwide. In Puget Sound, great strides were made retrofitting existing wastewater treatments plants to provide secondary treatment and, consequently, reducing pollutant loadings from these sources to Puget Sound. Today, several wastewater treatment plants are moving to advanced treatment and producing reclaimed water, which further decreases pollutant loadings to Puget Sound, and in the process provides another source of water supply for the region.

The same success story cannot be told of stormwater for several reasons. First, the federal, state, and local investments made to retrofit wastewater facilities have not been commensurately made to retrofit stormwater facilities. From 1970 to 1995, $61.1 billion in Federal Construction Grant Program funds were made available nationally. From 1988 to 2000, $16.1 billion in State Revolving Loan funds were made available for investments in wastewater quality improvement (see Appendix A, Section 5). While recently significant state and federal investments are being made in stormwater controls ($54 million in the current biennium), the level of investment has not yet reached the scale of historical investment in wastewater.

Until relatively recently, stormwater was considered "clean water" and separated from many wastewater systems. The large number of stormwater facilities constructed prior to the promulgation of the first Stormwater Management Manual for Western Washington in 1992 (and its gradual subsequent implementation and subsequent revisions) cannot be expected in most cases to include water quality control features. The majority (Appendix A) of urban stormwater discharged to Puget Sound comes from these old systems.

Second, even though treated under the law as a "point source," no stormwater utility operator has knowledge or control over the inputs to their system that a wastewater utility operator has due to the *open* nature of the stormwater system.

While the technologies for treating wastewater are highly advanced, similar technologies are less advanced or being developed for treating the much larger, intermittent, dilute volumes of urban stormwater to meet water quality standards. The best management practices (BMPs) promulgated in the Stormwater Management Manual for Western Washington (revised 2005) are presumed to meet water quality standards when implemented.

An Ecology report, Focus on Toxic Chemicals in Puget Sound (Ecology 2010a), draws the following conclusions:

> The most recent calculations confirm the state's previous findings that surface runoff is the main pathway for toxic chemicals getting into Puget Sound. Ecology currently estimates that Puget Sound receives between 14 and 94 million pounds of toxic pollutants annually, which include oil and grease, PCBs, phthalates (a plasticizer), PBDEs (flame retardants), as well as toxic heavy metals such as copper, lead, and zinc.…Toxic chemicals are getting into the Sound mostly from developed land, such as residential, commercial, and industrial areas…The findings indicate that as the region develops into the future, we will need a combination of pollution prevention and better stormwater controls to protect Puget Sound's health.

The Stormwater Management Manual for Western Washington (revised 2005) contains presumptive removal efficiencies for solids loadings, which may or may not have a relationship to individual toxic chemicals. Examples include dissolved zinc from tires and building materials; dissolved copper from building materials, herbicides, and automobiles; pesticides, phthalates from plastic containers and cosmetics, and polybrominated diphenyl ethers (PBDEs) used in flame retardants (Booth et al. 2006).

Based on the experience of MS4 permittees, it is difficult for local governments to fulfill their responsibilities for cleaning up stormwater because they do not have the following: an ability to control pollutant inputs, or a clear statement of hypotheses or metrics and monitoring to know what is being accomplished, or technological treatment that can achieve water quality standards with confidence, or the necessary level of investment to maintain and retrofit old systems. Without the ability to demonstrate that a given level of investment in capital facilities and/or maintenance and operations will result in cleaner surface waters, it has been difficult to convince the public and policy makers that stormwater deserves additional funding.

4. STORMWATER CHANGES TO THE NATURAL HYDROLOGY

The changes to the natural hydrology and stream ecology associated with land development, and in particular impervious surfaces, has been well studied for decades (see Puget Sound Action Agenda [2009] and State of the Sound [2010] report references).

Given the precipitation pattern, topography, and soils of the Puget Sound basin, controlling flooding, erosion, and landslides has been a priority that predates the NPDES MS4 permit requirements. The first fully functioning drainage utility in the nation was established by the City of Bellevue in the mid-1970s to retain its many small streams in an open drainage system, and to control urban flooding through on-site and regional detention facilities. Bellevue's utility formation was later followed by many counties and cities to the point that most significant urban areas in the Puget Sound basin at this time have some type of drainage utility or designated stormwater funding. These early approaches that preceded the NPDES permits focused almost completely on flow controls and small urban streams, but did not include rivers.

Initial designs to mitigate the impacts of increased flows and velocities on the natural system tended to be mostly structural, such as hard-surface detention facilities, vaults, and pipes. The concept of these designs was to collect and store stormwater, and attenuate its flow into or within the natural or structural system so as to avoid flooding and property damage, generally through off-stream or in-stream detention facilities. A consequence of the combination of increased impervious surface and many drainage system structural designs was to reduce groundwater recharge, which resulted in reducing flows from streams during dry weather and depleting aquifers. As the water quality and low flow impacts of stormwater facilities became more of a concern, designs changed to include more non-structural options such as vegetated swales, open detention facilities both wet and dry, and recharge and infiltration facilities.

Today, the design criteria for flow mitigation and water pollution abatement for stormwater are contained in the Stormwater Management Manual for Western Washington, first adopted in 1992, and last updated in 2005. NPDES permittees are required to adopt the Manual or its equivalent as a permit condition. For a summary of information on the types and benefits of the various stormwater control designs, please see the PSP Discussion Paper: Water Quality Topic Forum, July 11, 2008.

The advent of listings of salmonids in the Puget Sound basin under the Endangered Species Act (ESA) in 1998 added a new impetus to controlling stormwater impacts to stream and river hydrology and ecology. Habitat was added as an important dimension and changed again the manner in which stormwater mitigation was viewed. Rivers began to be included in what heretofore were primarily local drainage stormwater programs. River structures to control large-scale flooding such as levees, dikes, gabions, and dams that destroyed salmonid habitat became candidates for restoration. Hard-surface structures began to give way to large woody debris for stream and river bank stabilization. While significant progress has been made, one intractable barrier has been the lack of coordination and conflict resolution between the U.S. Army Corps of Engineers (which certifies many of the region's dikes and levees) and the National Oceanic and Atmospheric Administration (NOAA) (which administers the ESA for migrating salmonids) over the issue of levee vegetation management on rivers.

Despite this barrier, current views are progressing to consider and treat the watershed ecological system as a whole process rather than focusing on individual actions on pieces of the system (Fischenish 2006; Ecology 2010b). This maturing focus on watersheds ushered in a more holistic approach to stormwater impacts and controls to include prevention of re-contamination of remediated sediments; the protection of shellfish beds, shorelines, and wetlands; and contribution to lake trophic status. An outcome of this progress is that flow, water quality, and habitat have converged to create new ways to think about, preserve, and restore the Puget Sound basin's ecology from stormwater impact.

5. IMPLEMENTATION OF THE NPDES PERMIT PROGRAM

This section discusses the policy and regulatory framework in which urban stormwater is managed in the Puget Sound basin, and how these regulations (CWA and NPDES permit programs) influence the actions of governmental entities.

5.1 REGULATORY FRAMEWORK FOR URBAN STORMWATER

Although many regulations affect the practice of stormwater management at the local jurisdictional level, the primary driver is the CWA, first adopted in 1972, which sets the policy and regulatory framework for stormwater pollution control in the nation. The NPDES permit is the primary instrument to control urban stormwater. To understand the NPDES permit program for urban stormwater today requires going back some decades. Prior to the advent of the CWA in 1972, urban stormwater focus was on prevention of flooding, and from a municipal standpoint usually street flooding. Stormwater was considered "clean" and eventually separated from the wastewater system into two separate piped systems. The existing combined sewer systems are a remnant of the past, and remain usually because they were too expensive to separate.

Even after the CWA was implemented, it took almost 20 years before stormwater was recognized and regulated as a point source through significant national litigation. Since the State of Washington was delegated authority by the U.S. Environmental Protection Agency (EPA) to implement the NPDES permit system, Ecology initiated the first municipal stormwater NPDES MS4 permit program in 1995, combined with the State Waste Discharge Permit, for jurisdictions having population greater than 100,000. These became the first Phase I permittees. Later (2007), Ecology issued the Phase II permits to jurisdictions that owned or operated regulated small MS4s.

5.2 APPLICABILITY AND GEOGRAPHIC COVERAGE

Today, the Phase I municipal permittees in the Puget Sound basin are King, Pierce, and Snohomish Counties, as well as the Cities of Tacoma and Seattle. The Ports of Seattle and Tacoma are secondary permittees to the Phase I permits [Phase I Municipal Stormwater Permit, 2007]. There are 76 Phase II cities and counties in the Puget Sound basin [Western Washington Phase II Municipal Stormwater Permit, 2007]. The Municipal Stormwater Permits are renewed every 5 years with the next re-issuance in 2012.

While these Phase I and Phase II permittees represent about 45 to 50 percent of the land base in the Puget Sound basin, the permits only address areas with structural stormwater systems generally associated with impervious surfaces. Because only about 4 percent of the Puget Sound basin is impervious, the impact of urban lands is either disproportionately large compared to other land uses, or significant efforts will also be needed to address agricultural, timber, and other non-urban land uses.

5.3 MEETING WATER POLLUTION CONTROL STANDARDS

The Municipal Stormwater NPDES permit (Sections S4 and S5) states:

- The NPDES permit "…does not authorize a violation of Washington State surface water quality standards…ground water quality standards…sediment management standards…"
- Requires that the permittee "…shall reduce the discharge of pollutants to the maximum extent practicable (MEP)."

- Requires "all known, available, and reasonable methods of prevention, control and treatment (AKART) to prevent and control pollution of waters of the State of Washington."
- Additional requirements may exist in areas that have an established Total maximum Daily Load (TMDL).

BMPs are promulgated as minimum requirements to meet MEP and AKART. The NPDES permits require adoption of the 2005 Stormwater Management Manual for Western Washington, which is presumed to meet AKART. The 2005 edition contains water quality design criteria based on 80 percent total suspended solids (TSS) removal. According to the Manual, these presumptive practices do not guarantee that stormwater discharges will meet receiving water quality standards. The monitoring requirements for the Phase I permittees have not yet yielded sufficient data to determine whether receiving water quality standards are being met, or to determine removal efficiencies of nutrients, pathogens, or toxic chemicals. Phase I permittees could produce quantitative data only on what volume of solids loadings are being removed from the system through their maintenance and operation (M&O) programs on existing stormwater facilities. Phase II permittees do not yet have a monitoring requirement.

While solids loadings do not necessarily relate directly to receiving water pollutant concentrations, they are the best quantitative measure currently available to assess the pollution control benefits of the NPDES permit program. Moreover, they are the metric selected by the Manual for water quality, i.e., 80 percent TSS reduction. For the remainder of this task, solid loadings, rather than concentrations will be analyzed as a surrogate for pollutant loadings due to stormwater. Hopefully, scientific research will eventually make the necessary relationships among solids loadings and other pollutants of concern, and loadings and receiving water concentrations for stormwater (Puget Sound Stormwater Work Group 2010).

5.4 NPDES PROGRAM PERMITTEE CURRENT COSTS (TOTAL AND M&O COSTS) AND POLLUTANT LOAD REDUCTIONS

The scope of this task, in part, is to assess the needs of cities and counties for full implementation of the NPDES permit program in the Puget Sound basin. In order to assess the need, the existing investment in NPDES implementation was assembled directly from municipal Phase I and Phase II permittees in the Puget Sound basin. To sum the costs across the Puget Sound basin, the year 2009 was selected. Where cost information for permittees was not available or not provided, estimates were made based on available Phase I and II costs and normalized by population to fill the gaps (population data taken from www.ofm.wa.gov/pop/popden/default.asp).

The cost numbers should be considered only on a very coarse scale to demonstrate overall permittee spending to implement their NPDES permits in 2009. Cities generally have more concentrated stormwater systems serving denser levels of development that are generally more efficient to maintain as contrasted to counties with less dense development and higher travel costs. Disposal costs are variable. Phase I permittees have more requirements to meet than Phase II permittees, such as monitoring, retrofit plans, and a source control program for stormwater discharges from existing development. No jurisdiction calculates its M&O costs in the same manner. The costs also do not include land and capital costs and therefore are not only coarse estimates but conservatively low. The purpose of collecting this information was not to compare costs among permittees but to determine the existing level of investments being made specifically in implementing the elements of the NDPES permit. Estimates of total urban stormwater spending reported by others are higher inasmuch as they include local urban stormwater program revenues and costs for local drainage controls, capital and land costs (personal communication: Dave Williams, Assoc. of Washington Cities). Therefore, the costs included in this study should be considered conservative estimates by local governments in controlling urban stormwater in Puget Sound.

All municipal Phase I permittees in the Puget Sound basin provided estimates of total NPDES implementation costs, M&O costs, and solids removed. Based on these consolidated estimates, Phase I permittees invested $62.8 million in implementing their NPDES permit programs in 2009. Phase I permittees spent on the average about $40 per capita in 2009 within their jurisdictions for permit implementation activities. The M&O costs averaged 35 percent of the total NPDES costs (range 23 to 51 percent).

Metrics were sought that would provide a measure of the benefits of the existing NPDES MS4 permit program. The NPDES MS4 permit program has many good programs but few at this stage have associated performance metrics directly related to pollutant loadings. Direct measurements of load reductions currently available are the solids removed (TSS load reductions) from the systems through municipal M&O programs. Such practices include routine maintenance of pipes, inlets, and catch basin cleaning; street cleaning; detention system and vault cleaning; ditch maintenance; road striping and repair; snow, ice, and dust control; utility installations; landscape maintenance; sediment and erosion control; and similar "house-keeping" practices Phase 1 permittees removed 233,700 tons of TSS with their M&O programs costing $22.4 million. The cost per ton of TSS removed was highly variable and appeared to be more a function of the data collection methodology used by each jurisdiction than anything else.

Communications with many public stormwater agencies (NPDES permittees) and Washington State Department of Transportation (WSDOT) suggest that the transportation system, comprising the street surface and associated stormwater systems (catch basins, detention facilities, inlets, pipes, vaults, etc.), has a substantial load of solids that has accumulated over the years due to underfunded maintenance programs; this underfunding has resulted in reduced maintenance of the stormwater systems. This accumulation of materials in the stormwater system is referred to as "the legacy load." For example, the Phase I permittees alone in aggregate removed in 2009 about half the annual modeled load of solids from all impervious surfaces for the Puget Sound basin (Appendix A). The large legacy load is deemed to be from past long-term underfunded maintenance of these transportation and stormwater systems. All agencies participating in this work reported insufficient funding to accelerate the removal of the legacy loads.

The best and most recent local data (water quality and cost) found on the issue of legacy loads was from the City of Tacoma for the Thea Foss and Wheeler-Osgood Waterways (City of Tacoma 2010). According to this report under the EPA Superfund Program, contaminated bottom sediments were remediated in these waterways at a cost of $105 million. The City engaged in a source control and stormwater monitoring strategy to provide long-term protection of sediment quality in the waterways. When source controls alone were not achieving the level of results necessary to protect the waterways, Tacoma initiated an intensive basin-wide cleaning program of the storm sewer lines discharging to the waterways tributary for the three entire drainage basins. The goal was to remove legacy loads from periods prior to the source controls implementation. In 2007 over a 2-month period, the municipal storm systems tributary to the waterways were cleaned and inspected via television monitoring at a cost of $300,000. This work included cleaning 80,000 feet of 8-inch to 56inch lines and removing 220 cubic yards of storm sediments from the conveyance lines, laterals, and catch basins.

Good results were obtained for some pollutants of concern. Sewer line cleaning appears to have been most effective at removing lead (approximately 30 percent reduction in two out of three areas) and polycyclic aromatic hydrocarbons (PAHs) (40 to 60 percent reduction in all three areas, including both light and heavy PAH fractions) from stormwater. For future cost estimating purposes, Tacoma staff estimate the cost of such a program to be $10,000/pipe mile for pipe cleaning and about $600 to 800/ton for sediment removal. As a result of

Tacoma's program, the stormwater quality in the waterways continues to improve. Their program demonstrates the clear benefits and the relatively low cost of good stormwater facility maintenance (City of Tacoma, 2010).

Working with three of the Phase I permittees that had sufficient experience to make estimates, it appears that legacy loads could be removed at an estimated range of costs of $10,000 per pipe mile, $600 to $900 per catch basin, or $6,000 per road mile using a variety of techniques for flushing, vactoring, and high efficient street cleaning. Based on the limited Phase I permittee data available, to address the legacy loads would require a doubling to tripling of their M&O budgets each year for 5 years. To apply this estimate for all the permittees could be conservative because many of the Phase IIs are ramping up their M&O programs in this first period of experience with their permits (see the following paragraphs); however, some of the Phase Is have already removed some fraction of the legacy loads. If such an extrapolation were to be made, it would require roughly an additional $60 million to $120 million annually for M&O to remove legacy loads throughout the Puget Sound basin.

Permittees recognize that their MS4s receive TSS loadings from pervious landscapes, particularly construction-related loads, and also that 2009 produced an extraordinary load from snow and ice safety practices. Therefore, a direct comparison of NPDES removal efficiencies and those modeled for retrofits cannot be made.

There are 76 Phase II permittees in the Puget Sound basin. Because these permittees only received their first permits in 2007 and are still developing their programs, they did not have as much data as the Phase I permittees. They were asked only for their total NPDES implementation costs. Fifteen Phase II permittees responded ranging from small to large populations, including cities and counties, which were fairly representative throughout the Puget Sound basin (Clallam, King, Kitsap, Pierce, Skagit, Snohomish, and Thurston Counties represented). An interesting point is that based on the 15 Phase II permittees responding, the same level of spending of about $40 per capita was made as the Phase I permittees for 2009 NPDES permit implementation. Their total NPDES implementation costs were normalized by population, averaged, and then used to extrapolate the remaining permittee costs to obtain a coarse consolidated estimate of the level of investment of the Phase II permittees of $103 million in 2009. No estimates of TSS removal could be made.

The approximate $40/capita/year investment by permittees in NPDES permit implementation is confirmed by a case study published last year (Costs and Benefits of Storm-Water Management: Case Study of the Puget Sound Region, Visitacion, Booth, and Steinemann 2009). The case study consolidated cost data for stormwater management, including capital costs. The case study for 2007 reports that NPDES Phase I Municipal Stormwater Expenditures average $36/capita annually for NPDES costs, and total stormwater related costs average about $100/capita. The case study states:

> The relative costs of different types of storm-water management improvements vary widely, but systematically, between different jurisdictions. Efforts to reduce flooding and improve drainage are the largest costs among all jurisdictions, regardless of population or area. Overall, our data show that program-area spending, region wide, range from 25-100% for program budgets for flooding reduction and drainage improvement, 0-15% for landslide mitigation, 0-52% for habitat improvement, and 037% for improved water quality.

Interestingly, given the opinions of the 47 interviewees who participated in their study, the expenditure pattern is inverse to what they believe are or should be the priorities. Interviewees for the case study included municipal jurisdiction and state agency personnel charged with stormwater and MS4 responsibilities, environmental organizations, researchers, private consulting firms, and tribes. These interviewees were asked what they thought were the most significant stormwater impacts; the case study summarizes their response: "Overall, the interviewees felt that storm water has most significantly impacted water quality, with effects on biota and habitat being the second and third most significant impacts. The fourth most significant storm-water impact identified by the interviewees was flooding."

Because both Phase I and Phase II permittees spent about $40/person/year (2009), this was used with the total population in the Puget Sound basin NPDES permitted area to estimate the total local NPDES implementation investment in 2009: $ 165.8 million. Given the level of precision and conservatism in this estimate, the range of investment by permittees in 2009 is at least $160 to $170 million.

If the relationship is known between TSS and other pollutants of concern, such as nutrients, pathogens, and toxics, the reduction in their loadings from reduced TSS loadings could be estimated. Unfortunately, very few studies of the relationship between stormwater solids and adsorbed pollutants are available (Table 5-1). For example, what is known about the effectiveness of catch basins is limited to a few studies.

Table 5-1. Pollutants Addressed in Catch Basin Studies

Study	TSS	COD	BOD	TN	TP	Metals
Pitt et al. 1997	32	-		-	-	-
Aronson et al. 1983	60-97	10-56	54-88	-	-	-
Pitt and Shawley 1982	10-25	5-10	-	5-10 (TKN)	5-10	10-25 (Pb) 5-10 (Zn)
Mineart and Singh 1994	-	-	-	-	-	For Copper: 3-4* 15**

The toxic loadings study released by Ecology this year (Ecology 2010a) advances the knowledge of toxic chemical loadings from stormwater to Puget Sound, but does not associate the toxic loadings with solids loadings. Suspended solids in stormwater are associated with both heavy metals and PAHs (Lau & Stenstrom 2005). Removing suspended solids from stormwater will, at a minimum, remove solids-associated pollutants.

A body of work performed in the mid-1990s with an objective of characterizing vactor and street sweeping wastes does provide some data on the polluting potential of solids in stormwater and the benefit of removing them from the stormwater system. An Ecology study, Data Summary of Catch Basin and Vactor Waste Contamination in Washington State (Ecology 1993), reports the following results:

- CATCH BASIN SEDIMENT: Copper in residential catch basin sediments had a mean value between 20 and 126 parts per million (ppm), commercial area sediments ranged between 18 and 117 ppm, and industrial area sediments ranged between 165 and 456 ppm. Lead in residential catch basin sediments had a mean value between 101 and 636 ppm, commercial sediments ranged between 95 and 1726 ppm, and industrial sediments ranged between 230 and 500 ppm. Zinc in residential catch basin sediments had mean values between 174 and 336 ppm, commercial sediments ranged between 165 and 997 ppm, and industrial sediments ranged between 228 and 455 ppm. TPH in residential catch basin sediment had a mean value of 499 ppm, commercial mean values ranged between 52,400 and 60,000 ppm, and a single industrial sample had a value of 5,400 ppm.
- VACTOR SEDIMENT: Copper in residential vactor sediments had mean values of 24 and 28 ppm, commercial vactor sediment had a mean of 36 ppm, and industrial vactor sediment had mean values of 88 and 229 ppm. Lead in residential vactor sediment had mean values of 69 and 92 ppm, commercial vactor sediment had a mean value of 91 ppm, and industrial vactor sediment had mean values of 109 and 175 ppm. Zinc in residential vactor sediment had mean values of 106 and 138 ppm, commercial vactor sediments had a mean of 208 ppm, and industrial vactor sediments had mean values of 219 and 338 ppm. TPH in residential vactor sediments had means

of 401 and 1293 ppm, a mean of 2197 for industrial vactor sediments, and a mean of 276 for highway vactor sediments. There were no data for commercial vactor sediments.

Subsequent work in Snohomish County—Vactor and Street Sweeping Waste Characteristics (Snohomish County 1994) and Street Waste Characterization (Snohomish County 1995)—also found that street waste sediments are contaminated with similar pollutants. They found that metals (arsenic, cadmium, chromium, lead, and mercury), total petroleum hydrocarbons (TPH), PAH, and carcinogenic PAH are detected in street waste samples. In addition:

> "Chromatogram data indicate that sources likely to contribute to TPH concentrations in street waste include organic material, vehicle tires, asphalt paving materials, and motor oil and lubricants from cars and trucks. The similarity of the street waste peak with the used tire reference material peak suggests a significant contribution from tires to street waste. Relative amounts of contribution to the TPH concentration are not known."

Even if no quantitative estimate can be made to associate the amount of TSS removal and removals of other pollutants of concern at this time, the above sources show that the solids removed by maintenance of existing stormwater systems, as required by the NPDES permit program, do remove other pollutants of concern.

5.5 SOURCE CONTROLS

Phase I permittees, all of which have numerous industrial, commercial, and multifamily properties, are required to inspect 20 percent of those properties considered potentially polluting per year. Some Phase I permittees with highly urbanized communities expressed doubt that 100 percent of the inspections could be accomplished within the 5-year term of the permit (which, while desirable, is not an actual permit requirement because repeat inspections are sometimes necessary to gain compliance).

Working with two Phase I permittees, a range of costs to accomplish 100 percent of the inspections, and achieve 85 percent compliance, is estimated to cost from $40 to $110 per impervious acre per year. Based on these estimates applied to the acres of 80 to 100 percent impervious, as a coarse estimate of industrial and commercial potentially polluting properties with significant drainage facilities (about 67,000 acres in 2006; see Appendix A), inspection investment could be $2.7 to $7.4 million annually should this requirement be extended to all permittees to achieve 85 percent compliance within 5 years.

The NPDES permits also contain requirements for the identification and elimination of illicit discharges, illegal dumping, and spills. These programs have already demonstrated that a wide variety of illicit discharges exist in the stormwater systems ranging from sewer hookups, to floor drains, to non-permitted industrial discharges (MS4 Permit Improvement Guide, EPA, April 2010) Three examples of illicit connections identified by this program that demonstrate the benefit of the program are as follows:

1. A business that manufactures concrete products was inspected in 2009. The discharge point of their stormwater system was not mapped on the City's GIS system. The inspector dye-tested the concrete processing area, where process water (high pH and turbid) containing concrete residue was pumped to a trench drain. The dye test showed that the trench drain actually drained to the stormwater system, which then discharged to the Duwamish River. As a result of the inspection, the business rerouted the connection to the sanitary sewer and applied for an industrial waste permit for the discharge. The connection is suspected to have been in place for over 20 years. In addition, the business installed a stormwater treatment system for the outdoor material storage area on their site. The site also has an NPDES permit with Ecology.

2. A lumber company was inspected in 2009. The business stores and sells treated lumber, which was leaching metals, including arsenic, copper, and zinc, onto the property and into the street right-of-way. As a result of the inspection process, the business improved their source control practices, moved the material storage location, and worked with the manufacturer to improve the drying process of the material before it came on site. The site was referred to Ecology for an NPDES permit. The street right-of-way drained to the Duwamish River.
3. A warehouse housing at least 10 tenants was inspected in 2009. Most of the plumbing improvements in the building were completed without permit. As part of the inspection process, the bathrooms of a tenant were dye-tested due to inconsistencies in the mapping and suspicious cuts in the outdoor pavement area that indicated recent plumbing activity. The bathrooms were found to be plumbed to the storm drain system, which drains to the Duwamish River.

Both Phase I and Phase II permittees are required to have enforcement programs but Phase II permittee requirements are still being phased in and not yet included in some of their budgets. The NPDES permit requires that authority for compliance and enforcement be included in local ordinances but it does not require the level of enforcement beyond identification, notices, and warnings. Robust compliance and enforcement programs are time intensive and expensive. Compliance and enforcement resources are extremely limited for local municipalities according to the permittee interviews.

Table 5-2 summarizes the results from 2009 for the Phase I permittees for their source control programs.

Table 5-2. Summary of 2009 Phase I Permittee Source Control Programs

Program Element	2009 Activity
Sites provided information about pollution generating activities and source control	10,181
Sites identified through legitimate complaints	1,353
Sites inspected to follow up on legitimate complaints	1,353
Enforcement actions to bring sites into compliance	1,962
Followup actions to bring sites into compliance	623
Number of source control violations reported to Ecology that could present a threat to human health or the environment	211
Investigations initiated within 21 days of discovering an illicit connection	74
Enforcement actions taken to eliminate illicit connection within 6 months of discovery	9
Illicit connections eliminated	30
Illicit connections referred to Ecology after making good faith and documented enforcement effort to terminate illicit connection	0

Lacking representative quantitative cost data, model programs were sought that did have costs associated with them. There are several excellent pollutant reduction programs in the region. One program, the Kitsap Pollution Identification and Correction (PIC) program, stood out as a particularly good model for the identification and elimination of specific sources of pollution that had accompanying cost data. To quote from the Kitsap PIC program:

> "Pollution Identification and Correction (PIC) Projects are conducted to determine the causes and sources of bacterial water pollution in specific geographical areas. Common sources of bacterial pollution include failing on-site sewage systems and animal waste." The Kitsap PIC program has developed a prioritized list of areas in Kitsap County that are in need of a pollution identification and correction project. Projects are generally funded by the Kitsap County Surface and Stormwater Management Program and grants from Ecology.

The goals of the PIC project are to:

- Protect public health;
- Protect shellfish resources; and
- Preserve, protect, and restore surface water quality.

One of the strongest features of the program is the prioritization criteria (included in Section 6.2.3 of this report), which could have broader application for additional pollutants important to the recovery of Puget Sound (Kitsap Public Health, 2010 PIC priorities).

The Kitsap PIC program has had good success. Since 1996 this program has:

- Assisted with restoration of 8 shellfish growing areas (2,987 acres); Yukon Harbor and North Dyes Inlet are most notable.
- Conducted 4,652 property surveys and educational site visits as part of 18 large-scale cleanups, and located and repaired 365 failing on-site sewage systems.
- Investigated 3,390 public on-site sewage complaints and repaired 885 systems.

- Improved water quality in 11 Kitsap County streams and 4 marine embayments after completion of pollution identification and correction projects.
- Responded to low dissolved oxygen issues in Hood Canal by conducting survey and on-site sewage system repairs along the entire Kitsap County shoreline, including Port Gamble Bay.
- Installed 15 new sewage control devices at Kitsap County marinas through enforcement of regulations.

Shellfish and public health is an important local priority for Kitsap County. Other regions may have different local priorities, such as salmon pre-spawn mortality, Superfund cleanup of sediments/recontamination from stormwater, or stream temperature impairments. By substituting any water pollutant of concern for fecal coliform bacteria, the priorities selected for PIC could guide compliance and enforcement, and even public investments, for water quality improvement from stormwater and non-point sources.

The 2009 cost for this program was $1,300,000. Approximately $500,000 is needed annually from Ecology and EPA to sustain the current level of program activity and accomplishments. Based on communications with the Kitsap PIC program staff, their average PIC cost per stream mile is approximately $20,000 and the average cost per marine shoreline mile is about $15,000. According to Ecology [Puget Sound Shoreline Management Act shorelines], there are 3,022 miles of marine shoreline, 1,181 miles of lake shorelines (over 20 acres), and 3,664 stream miles (over 20 cubic feet per second [cfs] mean annual flow) in the Puget Sound basin. A subset of these areas is 303(d) listed under the Clean Water Act; some have associated total maximum daily load (TMDL) requirements; some are Superfund cleanup sites; and some have closed shellfish beds or closed swimming beaches. The approximate number of these identified problem areas is about 550 [http:/www.ecy.wa.gov/programs/wq /tmdl/TMDLsbyWria/TMDLbyWria.html]. Assuming each investigation would involve at least 1 mile of shoreline, the cost to investigate all these known areas in the Puget Sound basin, based on the Kitsap PIC program experience, could range from about $8 million to $11 million annually. This is a very conservative estimate based on program costs that largely focus on bacterial contamination in smaller stream and river basins. Programs that focus on toxic contamination over larger watersheds would cost considerably more.

5.6 REGULATION OF NEW DEVELOPMENT AND REDEVELOPMENT

The Stormwater Management Manual for Western Washington (Ecology 2005) contains the requirements for new development and redevelopment in the Puget Sound basin. The Manual uses TSS as a surrogate for a water quality target to be achieved, i.e. 80 percent TSS removal.

A separate body of work is in progress on Low Impact Development (LID) techniques through a committee led by Ecology. LID techniques are designed to better imitate the natural site ecology, rather than the more structural approaches that have historically been used to control stormwater. Recent work (PSAT, 2005; University of New Hampshire Stormwater Center, 2009) shows that LID techniques can provide improved removal efficiencies beyond TSS to include significant nutrient, pathogen, and toxic chemical reductions. A ruling by the Pollution Control Hearings Board requires the application of LID techniques for new development in Western Washington where feasible. .LID techniques could significantly advance stormwater management from future development and re-development (testimony to the PCHB, Dr. Richard Horner, 2008) The LID committee is expected to present its work later in 2010

Inasmuch as this study is not to duplicate the work of other studies such as the LID work group, no estimates could be made of the resource needs to implement LID as part of the

NPDES permit program at this time. As a consequence, estimates included in this report are largely for the improvement of water quality discharges from existing stormwater systems through maintenance, operations, inspections, source controls and retrofits as contrasted to expected water quality results associated with future development and re-development.

5.7 PUBLIC EDUCATION PROGRAMS

The NPDES permit requires permittees to provide and measure the impact of public education programs aimed at controlling sources of pollution in stormwater. Information in sufficient quantity to estimate overall costs of this aspect of the NPDES permit program, or metrics on its effectiveness, was not able to be obtained at this time. Over time, with additional experience and data collection, permittees may be able to demonstrate throughout Puget Sound that behavioral changes are improving water quality.

Lacking quantitative data, there is one model, King County's Environmental Behavior Index or EBI, for measuring the benefits of public education on behaviors that should result in improved environmental outcomes, including water quality and cost data. Figure 5-1 is a digest of some of the stormwater-related data collected by King County's most recent survey in 2008 and compared to 2006:

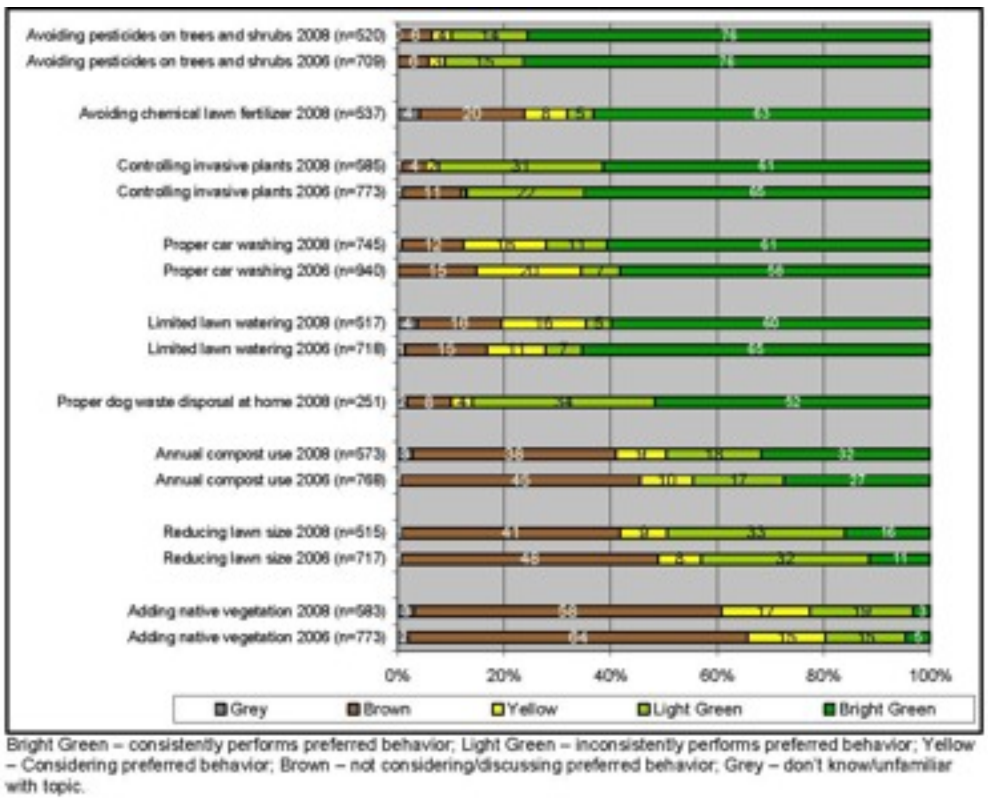

Figure 5-1 Environmental Behavior Survey Result (King County, 2006 and 2008)

While not a direct measure of water quality benefit, it is a measure of intermediate outcomes that are on the path to water quality improvements. The EBI is designed to:

1. Identify behaviors that are ripe for change;
2. Target population segments for increased focus; and
3. Support evaluation by gauging program and/or outreach campaign effectiveness.

Over time the EBI may demonstrate whether the costs of public education programs are providing good value reaching intended audiences and changing behaviors. The cost of the

EBI survey every 2 years for King County is $45,000. When results are compared for such long-standing public education programs as Waste Reduction and Recycling (WRR), for example in the Seattle/King County area, the WRR rate achieved was less than the 65 percent goal desired; currently, the WRR rate is at about 50 percent, which has stood for several years. This suggests that there may be a practical limit to the amount of behavioral change that can be relied upon through public education programs alone. The WRR programs in King County found that education, combined with infrastructure changes and policy changes (e.g., disposal bans on certain recyclables), is needed to achieve high behavioral change.

Figure 5-2 contains survey data on transportation behaviors as well. Impervious surfaces related to transportation, and the pollutant byproducts from vehicles, are sources of ubiquitous adverse hydrologic and water quality impacts to surface waters, such as copper from brake linings or zinc from tires (Kayhanian et al. 2002). Reductions in vehicle miles traveled, or VMT, has been the focus of climate change mitigation. It also has benefits for air quality and federal energy independence policies. VMT was considered in the policy analysis of the Transportation 2040 Policy Analysis and Evaluation Report for water quality impacts on stormwater (PSRC 2009). Stormwater benefits can be added to this community of interest for reducing VMT per capita in the future.

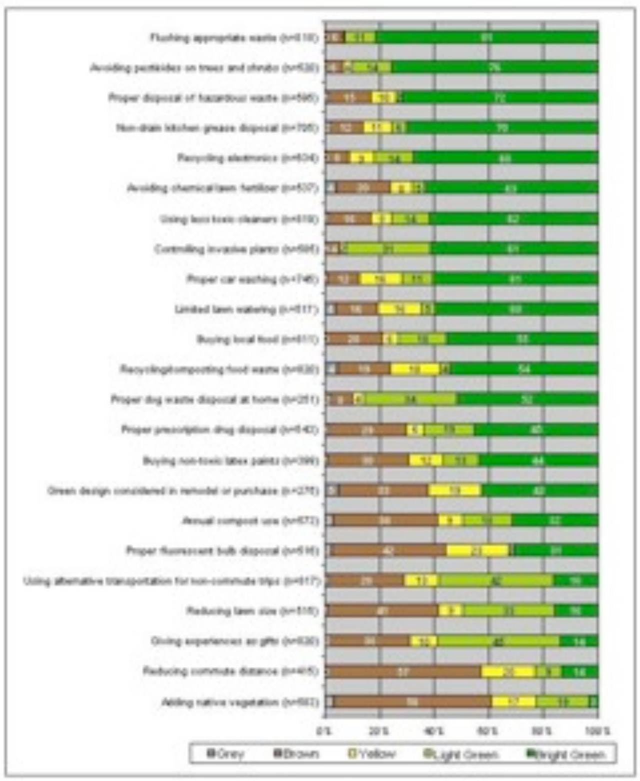

Figure 5-2. Environmental Behavior Survey King County, 2008

5.8 MONITORING

The Phase I permittees are required to monitor their stormwater systems representatively, including outfalls, BMP effectiveness, and background. Over time, the data collected is expected to guide adjustment of the NPDES permit program toward greater effectiveness. Monitoring is an expensive component currently for the Phase I permittees. The Phase II permittees are preparing to have a monitoring requirement included in their next permit renewal. Ecology formed a Stormwater Work Group to collaboratively develop a regional monitoring program for the NPDES permit program. Their work is to be published in 2010 and is expected to inform the monitoring requirements of both sets of permittees in the 2012 permit renewal. For further information on NPDES monitoring, refer to Puget Sound Stormwater Work Group (2010). The results of the Work Group's work are provided in the draft currently out for review and comment. Three tiers of monitoring are recommended: (1) status and trends, (2) source identification, and (3) BMP effectiveness. The results suggest that the estimated 5-year cost of the regional stormwater monitoring program ranges from $42,000,000 to $73,350,000, with permitted municipalities contributing from $15,000,000 to $50,000,000 (or $3 million to $10 million annually)..

5.9 REPORTING REQUIREMENTS

The Phase I and Phase II permits both require annual reporting of implementation activities on the major sections of the permit covered above. These reports can be found on the Ecology website and were used in sections of this report. Over time, these annual reports should provide a growing body of data and information to better analyze questions addressed in this study.

5.10 STATE NPDES PERMIT PROGRAM FUNDING

WSDOT is also an NPDES permittee. WSDOT projects a steeply increasing program cost for its statewide program as it ramps up to full NPDES permit implementation:

2009-2011	$2,385,000 (actual)
FY 2011 Supplemental	$2,425,000 (actual)
2011-2013	$22,189,000 (current estimate)

According to WSDOT, approximately 75 percent of its NPDES program is implemented in the Puget Sound basin.

Funding identified for the 2011 to 2013 biennium is required to continue implementation of the department's statewide stormwater management responsibilities to meet operational and timeline requirements mandated by the stormwater permit issued by Ecology in February 2009. The 2009 permit expands coverage to more than 100 urban areas across the state and the number of regulated state highway centerline miles has increased 40 percent, from 1,140 to 1,600. Under the 2009 permit, the department is responsible for the following:

- Five-fold increase in the amount of environmental testing for stormwater over the prior permit (testing must start at 20 locations by September 2011).
- Inventory and map stormwater sewer system, including outfalls, runoff treatment and flow control facilities, and their conveyances; inventory and map connections to municipal storm sewers; and initiate an ongoing program to keep the stormwater features inventory updated by March 2014.
- Annual inspection and maintenance of catch basins within the permit area beginning March 2011.
- Annual inspection and maintenance of stormwater treatment facilities (e.g., ponds, bioswales) within the permit area beginning March 2012.
- Improvements at maintenance facilities, park-and-ride lots, ferry terminals, and rest areas as stated in the pollution prevention plans throughout the 2011 to 2013 biennium.
- Significantly expanded tracking and reporting of stormwater management program implementation and permit compliance.

- Washington State Ferries have responsibility for their shoreside operations, which consist of terminals, parking areas, and holding lanes.

Ecology administers the NPDES permit program for urban stormwater among its other NPDES permit programs for industrial, construction, and wastewater programs. Ecology's current annual funding level for the municipal stormwater NPDES permit program implementation is $1,214,743 (Fiscal Year [FY] 2009) and is proposed to be increased annually to $3,767,602 (Ecology 2010c). The nearly tripling of the revenue is needed to cover full funding of the NPDES permit program implementation including renewing and issuing permits, responding to appeals, data management, report reviews, compliance reviews, technical assistance, compliance activities, and addressing unique situations. Ecology reports that approximately 80 percent of these costs are expended within the Puget Sound basin.

These costs do not include stormwater construction permit programs, which are currently expending $1,993,411 (FY 2009) and are proposed to go to $4,836,865 annually, nor do these costs include industrial stormwater permit programs, which are currently expending $1,328,906 (FY 2009) and are proposed to go to $2,564,121. The need for Ecology's full implementation of the stormwater NPDES permit program statewide is $11,168,088, up from $4,537,060—an increase of $6,631,028 or about 150 percent over current spending. Given the current and potential benefits from the NPDES permit program, at least as measured by the amount of solids and associated other pollutants removed from the stormwater systems by Phase I municipal stormwater agencies, a fully supported NPDES permit program for Ecology appears to be a cost-effective measure.

6. STORMWATER RETROFITS

Much of the development that exists in the Puget Sound drainage (the land area that drains into the Puget Sound, extending from the Olympic and Cascade Mountain crests to the marine shoreline) occurred prior to the adoption of Ecology's 1992 Stormwater Management Manual for Western Washington. It is likely, therefore, and as described in later paragraphs, that greater than 90 percent of the existing developed land base in Puget Sound discharges untreated stormwater, the majority of which is assumed to be undetained as well. As a result, retrofit of these existing untreated areas has been suggested as an important next step towards reducing stormwater impacts to Puget Sound. However, estimates of Puget Sound-wide funding needed to move the next step towards a retrofit policy have been lacking. This section attempts to move that next step by providing a coarse-grained analysis of potential costs and benefits that could accrue from the retrofit of significant areas of Puget Sound.

6.1 OVERVIEW OF APPROACH AND ASSUMPTIONS

To estimate the area that could benefit from retrofit and the potential costs and results achieved, the following approach was taken and assumptions made:

1. It was assumed that pre-Ecology stormwater manual estimates of imperviousness could serve as a coarse estimate of land that would not have received treatment using Ecology-recommended water quality BMPs. Because of the time lapse between issuance of the NPDES Phase I permits in 1995 and the requirement of those permits to subsequently adopt the Ecology manual, it was assumed that data sets available for 1996 could be reasonably representative.
2. Ecology-modified NOAA GIS data sets for 1996 (which are available at http://www.ecy.wa.gov/services/gis/data/landcover/basins.htm) were used to estimate impervious acreage within the Puget Sound drainage by watershed (WRIA) and county. This acreage was available by 1/4 acre, categorized in ranges of imperviousness coverage (0 to 19 percent, 20 to 49 percent, 50 to 79 percent, 80 to 100 percent). Imperviousness was classified based on Landsat spectral data using the methods described by Homer et al. (2004) and Yang et al. (2003). Note that this process classified open water as 0 percent impervious[1]. Impervious acreage was also estimated for Puget Sound NPDES stormwater-regulated jurisdictions, and for roads and public/private ownership in Kitsap and King Counties.
3. Eighty percent removal of TSS, the only current Ecology numeric standard for stormwater pollutant removal, was selected as a reasonable proxy for improvement in stormwater quality discharged to Puget Sound.
4. BMPs that would achieve 80 percent TSS removal were identified and scalable estimates of capital and maintenance costs developed for facilities that would provide TSS treatment for 1 acre of land with 100 percent imperviousness. Importantly, costs do not include land acquisition; facilities at the low and high end of the costs scale were assumed to be able to fit into existing rights-of-way. This assumption likely understates the investment needed. Moreover, cost estimates do not include personnel and other capacity issues that would be associated with intensifying efforts to implement stormwater retrofits throughout the region. Additionally, flow control was not included; thus, the estimates may understate the true costs, depending on the situation (e.g., downtown urban cores versus suburban parking areas).
5. An average of the high and low capital and maintenance estimates were then multiplied by the total impervious acreages in Puget Sound, where the

[1] In the Ecology/NOAA impervious data layer, all open waterbodies were assigned an imperviousness value of 0, meaning that all precipitation falling onto those open waterbodies would be absorbed and none would run off onto adjacent lands.

imperviousness calculations were made by county and WRIA to establish a gross estimate of retrofit investment needed.

6. A coarse calculation of potential stormwater retrofit benefit was made by estimating the tons of TSS that would be removed from the stormwater system for acreages with 50 percent and greater imperviousness. The focus on the 50 to 100 percent range of imperviousness was assumed to provide a reasonable narrowing given the coarse level of this analysis.

The remainder of this section provides an overview of results obtained. Appendix A provides more details on approach, assumptions, limitations, analysis, and findings.

6.2 IMPERVIOUS SURFACE ESTIMATION

There are roughly 8,700,000 acres in the Puget Sound drainage. Table 6-1 shows the total percent imperviousness in Puget Sound by 20 percent categories of imperviousness. For example, acreage in the 0 to 19 percent category represents property that has less than 20 percent imperviousness as measured on a ¼-acre-square basis. As shown in Table 6-1, about 3.7 percent of Puget Sound was impervious in 1996; 10 years later about 4.1 percent of the total area was impervious—a roughly 11 percent increase. King County comprised 37 percent of that imperviousness in 1996 and 34 percent in 2006, reflecting the rapid growth that occurred in other Puget Sound counties during that period (see Appendix A, Tables 3-2 and 3-4).

Table 6-1. Impervious Surface Estimation in Puget Sound Drainage

Category of % Imperviousness within 1/4 acre	0-19%	20-49%	50-79%	80-100%	Total
Total 1996 Impervious Acres within Category	36,747	120,462	101,995	60,206	319,409
Total 2006 Impervious Acres within Category	46,478	128,189	115,960	67,214	357,840
Percent Increase 1996 to 2006	26%	6%	14%	12%	12%
Total Puget Sound Acres	**8,700,000**				
Total Percent Impervious – 1996	3.7%				
Total Percent Impervious – 2006	4.1%				

6.2.1 Retrofit Cost Estimation

Thirteen BMPs were identified that were Technology Assessment Protocol—Ecology-approved under the General Use Level Designation. These BMPs could meet or exceed the Ecology standard of 80 percent TSS removal or greater and required no additional land acquisition. For each of these BMPs, installation and annual maintenance costs for treating 1 acre with 100 percent imperviousness were established as a scalable metric, which could be applied to the total imperviousness calculated in each category of imperviousness. Costs ranged from roughly $20,000 to 78,000 per acre for installation and $300 to $3,200 per acre for annual maintenance (see Figure 6-1 below). The costs provide estimated book ends within which TSS removal retrofit could occur. It should be noted that the BMPs shown have a wide range of effectiveness for other pollutant removal as well. For example, bioretention (shown as rain gardens in Figure 6-1) can remove 90 to 95 percent of metals and can greatly reduce flow volumes; wet ponds generally do not provide similar removal rates. Importantly, they do not include the costs to local jurisdictions of ramping up to accommodate a significantly increased work load nor do they address the availability in the region of a work force skilled in the design and ongoing maintenance of retrofit facilities.

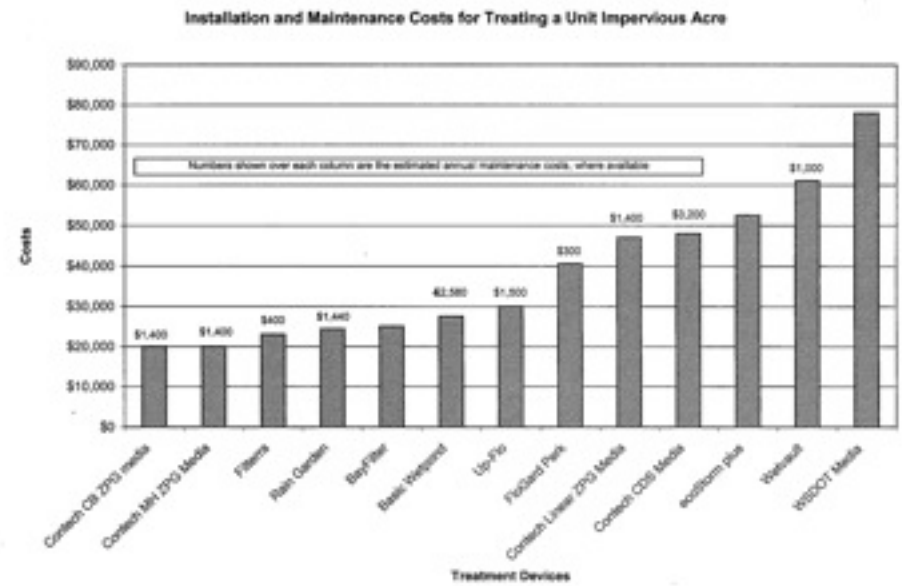

Figure 6-1. Installation and Maintenance Costs for Treating a Unit Impervious Acre

Based on the described analysis, retrofitting the roughly 162,200 acres of imperviousness, that is present at a level of 50 percent or greater imperviousness per 1/4 acre (Table 6-2, 50 to 100 percent imperviousness) could be coarsely estimated to cost $8 billion with annual maintenance costs of about $300 million (Table 6-2).

Table 6-2. Increasing Level of Potential Average Capital Investment to Retrofit Land from Most to Least Impervious

Range of Imperviousness Addressed	80-100%	50-100%	20-100%	0-100%
Acres with Impervious Area Addressed	60,206	162,201	282,663	319,409
Potential Capital Investment *(Average of Low and High Estimate in Appendix A, Table 12)*	$3,010M	$8,110M	$14,133M	$15,645M
Potential Annual Maintenance Investment *(Average of Low and High Estimate in Appendix A, Table 1-2)*	$111M	$300M	$523M	$561M

Tables 7-3 and 7-4 provide two additional looks at imperviousness data for Puget Sound that may be useful in considering different avenues for addressing retrofit. Table 6-3 shows the imperviousness for jurisdictions covered in 2010 by Phase 1 or 2 NPDES stormwater permits. Table 6-4 provides a subset analysis of the estimated public and private lands in Kitsap and King Counties, with an estimate of the portion of the public lands that could be attributed to road right-of-way.

Table 6-3. 2006 Impervious Surface Acres by NPDES Permit Status and County

		All Lands In the Puget Sound Drainage			NPDES Only		
		Land	Impervious	Percent	Land	Impervious	Percent
County	**NPDES Status**	**Acres**	**Acres**	**Impervious**	**Acres**	**Acres**	**Impervious**
Clallam	Non-NPDES City	4,006	1,216	30.37%			
	Non-NPDES County	619,320	7,054	1.14%			
	NPDES City	6,790	2,221	32.71%			
Clallam Total:		**630,115**	**10,491**	**1.67%**	**6,790**	**2,221**	**32.71%**
Island	Non-NPDES City	1,399	298	21.30%			
	Non-NPDES County	127,509	7,370	5.78%			
	NPDES City	6,022	1,895	31.47%			

Island Total:		**134,930**	**9,563**	**7.09%**	**6,022**	**1,895**	**31.47%**
Jefferson	Non-NPDES City	4,493	983	21.88%			
	Non-NPDES County	477,543	3,373	0.71%			
Jefferson Total:		**482,036**	**4,356**	**0.90%**	**0**	**0**	**N/A**
King	Non-NPDES City	8,336	1,380	16.56%			
	NPDES City	260,193	92,753	35.65%			
	Ph I NPDES County	1,132,457	27,887	2.46%			
King Total:		**1,400,985**	**122,020**	**8.71%**	**1,392,649**	**120,640**	**8.66%**
Kitsap	NPDES City	43,897	5,811	13.24%			
	Ph II NPDES County	211,442	12,850	6.08%			
Kitsap Total:		**255,339**	**18,662**	**7.31%**	**43,897**	**5,811**	**13.24%**
Mason	Non-NPDES City	3,682	880	23.91%			
	Non-NPDES County	477,976	5,587	1.17%			
Mason Total:		**481,658**	**6,467**	**1.34%**	**0**	**0**	**0.00%**
Pierce	Non-NPDES City	2,408	533	22.12%			
	NPDES City	94,166	34,965	37.13%			
	Ph I NPDES County	944,256	35,475	3.76%			
Pierce Total:		**1,040,830**	**70,973**	**6.82%**	**1,038,422**	**70,440**	**6.78%**
San Juan	Non-NPDES City	1,387	320	23.05%			
	Non-NPDES County	111,670	2,574	2.30%			
San Juan Total:		**113,057**	**2,894**	**2.56%**	**0**	**0**	**N/A**
Skagit	Non-NPDES City	2,253	359	15.95%			
	NPDES City	20,946	6,270	29.94%			
	Ph II NPDES County	1,100,232	11,735	1.07%			
Skagit Total:		**1,123,431**	**18,365**	**1.63%**	**20,946**	**6,270**	**29.94%**
Snohomish	Non-NPDES City	6,410	1,515	23.64%			
	NPDES City	78,550	26,499	33.73%			
	Ph I NPDES County	1,263,082	25,593	2.03%			
Snohomish Total:		**1,348,042**	**53,607**	**3.98%**	**1,341,632**	**52,092**	**3.88%**
Thurston	Non-NPDES City	4,707	728	15.47%			
	NPDES City	29,093	8,616	29.61%			
	Ph II NPDES County	231,313	8,429	3.64%			
Thurston Total:		**265,113**	**17,773**	**6.70%**	**29,093**	**8,616**	**29.61%**
Whatcom	Non-NPDES City	9,083	2,121	23.35%			
	NPDES City	22,162	6,424	28.99%			
	Ph II NPDES County	1,355,335	13,106	0.97%			
Whatcom Total:		**1,386,581**	**21,651**	**1.56%**	**22,162**	**6,424**	**28.99%**
Totals:		**8,662,117**	**356,822**	**4.12%**	**3,901,614**	**274,408**	**7.03%**

Note: For Phase II NPDES counties, the permits only apply to urban areas around permitted cities. Consequently, Phase II NPDES counties were not included in the calculations of NPDES-permitted land and impervious acres. However, urban growth areas outside of NPDES-permitted cities were not included in the analysis, so the total NPDES-permitted land and impervious acres for these counties are underestimated.

Section 4 of Appendix A provides a more detailed table of the estimates. The 162,200 untreated acres from the 50 to 100 percent impervious category, which are a candidate for retrofitting, includes both public and private lands. To segregate private from public lands would require extensive research of each county assessor's files and is beyond the scope of this report. However, Joan Lee and Margaret Spence did find data available for two counties—King and Kitsap that segregated county roads from all other impervious lands. Table 6-4 shows the total land and impervious acres for King and Kitsap Counties juxtaposed with the total public land ownership. Of the 674,000 and 50,500 acres of public land, respectively, about 42,100 and 8,400 acres are roads. It can then be estimated that public roads account for roughly 34 and 46 percent of impervious acres in King and Kitsap Counties, respectively. Public roads comprise the majority of public impervious lands, but do not count for public buildings or facilities. Based on these very limited examples, the proportion of public to private lands could be roughly estimated at about 50 percent. This split will be important to the development of a retrofit funding strategy.

Table 6-4. Total Land Acreage and Total Impervious Acreage in King and Kitsap Counties and the Subset of their Public Lands (Categorized as Roads and non-Roads)

County	Total Land Acres	Total Impervious Acres	Public Land Ownership Subset: Total Public Road (Impervious Surface Area)	Total Non-Road Public Lands	Total Public Lands
King	1,400,985	122,020	42,088	631,843	673,931
Kitsap	255,339	18,662	8,482	42,041	50,523

6.2.2 Estimates of Stormwater Retrofit Pollutant Load Benefits

A range of potential TSS concentrations in stormwater was established from the literature and an average established. This average was used to determine the potential TSS present in untreated stormwater and the amount that could be removed using BMPs. From that calculation, it was estimated that about 223,000 tons of TSS could be removed annually from the stormwater generated from the combined 50 to 100 percent imperviousness category at a capital cost of about $68,000 per ton and with annual maintenance costs of about $3,000 per ton.

Retrofitting currently untreated stormwater with basic water quality treatment facilities would reduce large quantities of solids (in tons) moving from land to adjacent water bodies. Table 6-5 shows the magnitude of the solids removal that could be achieved from retrofitting the 50 to 100 percent impervious surface acreage in the Puget Sound drainage, using a range of possible TSS concentrations from measured data (based on data from Han et al. 2006). Table 6-6 shows the average cost of TSS moved through retrofit facilities (by county and WRIA).

Table 6-5. Low and High Levels of TSS Removal from Lands with 50-100% Imperviousness

County	Untreated Tons (TSS – Low)	Treated Tons (TSS – Low)	Untreated Tons (TSS – High)	Treated Tons (TSS – High)
Clallam	2,722	545	14,411	2,883
Island	2,307	462	12,214	2,443
Jefferson	913	183	4,834	967
King	32,878	6,575	174,059	34,812
Kitsap	4,413	883	23,359	4,672
Mason	1,358	271	7,187	1,437
Pierce	17,375	3,474	91,986	18,398
San Juan	659	132	3,491	698
Skagit	4,327	865	22,906	4,581
Snohomish	12,575	2,515	66,575	13,315
Thurston	3,815	763	20,199	4,040
Whatcom	5,253	1,051	27,806	5,561
Totals	**88,592**	**17,720**	**469,026**	**93,806**

Table 6-6. Average Cost for TSS Removed through Retrofit Facilities

County	Average Estimate of TSS Removed (Ton)	Average Estimate of Capital Cost per Ton TSS Removed ($/Ton)	Average Estimate of Maintenance Cost per Ton of TSS Removed ($/Ton)
Average Estimate of TSS Removed (Ton)			

Clallam	6,853	69,000	3,000
Island	5,808	53,000	2,000
Jefferson	2,298	47,000	2,000
King	82,775	75,000	3,000
Kitsap	11,109	56,000	2,000
Mason	3,418	44,000	2,000
Pierce	43,744	70,000	3,000
San Juan	1,660	31,000	1,000
Skagit	10,893	63,000	2,000
Snohomish	31,660	66,000	2,000
Thurston	9,606	61,000	2,000
Whatcom	13,223	60,000	2,000
Totals	**223,047**	**68,000**	**3,000**

Table 6-6. Average Cost for TSS Removed through Retrofit Facilities (continued)

Average Estimate of TSS Removed (Ton)			
WRIA_Name	**Average Estimate of TSS Removed (Ton)**	**Average Estimate of Capital Cost per Ton TSS Removed ($M/Ton)**	**Average Estimate of Maintenance Cost per Ton TSS Removed ($M/ Ton)**
Nooksack	12,635	68,000	3,000
San Juan	1,660	31,000	1000
Lower Skagit/ Samish	9,778	75, 000	3,000
Upper Skagit	2,003	37,000	1,000
Stillaguamish	3,350	53,000	2,000
Island	5,808	59,000	2,000
Snohomish	19,376	76,000	3,000
Cedar-Sammamish	53,785	80,000	3,000
Duwamish-Green	31,556	88,000	3,000
Puyallup-White	24,223	86,000	3,000
Nisqually	4,985	56,000	2,000
Chambers-Clover	19,172	88,000	3,000
Deschutes	7,970	82,000	3,000
Kennedy-Goldsborough	2,921	48,000	2,000
Kitsap	14,530	58,000	2,000
Skokomish-Dosewallips	605	24,000	1,000
Quilcene-Snow	2,506	51,000	2,000
Elwha-Dungeness	6,054	77,000	3,000
Lyre-Hoko	431	45,000	2,000
Totals	**223,349**	**77,000**	**3,000**

Note: Totals for WRIAs are slightly higher than county totals. Two counties (Grays Harbor and Lewis) have relatively small upland areas that contribute to total WRIA acreage but are inconsequential in terms of contribution to impervious areas in the 50 to 100 percent range.

All of the water quality treatment systems that were evaluated are appropriate for TSS removal to meet the standard of 80 percent removal. Several of the systems provide additional water quality treatment benefits beyond TSS removal, including total phosphorus removal, oil/grease treatment, and heavy metals removal. Several studies were reviewed by contributors concerning removal efficiencies of toxic chemicals from stormwater for a number of stormwater designs and BMPs. The range of percent removals reported was such that these studies were of limited utility for making any reliable estimate of toxic removals associated with the proposed retrofit of the Puget Sound area. The scope of this work was limited to estimating TSS removal potential. Importantly, it also does not take a comprehensive look at the reduction of stormwater flows also needed throughout the region to achieve overall stream health.

Catch basin and street sweeping studies conducted by Ecology and Snohomish County in the 1990s (Ecology 1993; Snohomish County 1994, 1995) demonstrate the role of particulates in adsorbing stormwater contaminants. This was true for different land use types (residential, commercial, and industrial), as well as for different types of contaminants (metals, TPH, and fecal coliforms). For example, average solid phase concentrations in catch basins across different land uses for copper, zinc, and TPH were 92 mg/kg, 344 mg/kg, and 19,017 mg/kg, respectively (Ecology 1993). Using an estimated total solids removal of 234,000 tons based on Puget Sound Phase I NPDES data (Bissonette personal communication), these would be equivalent to 22 tons of copper, 80 tons of zinc, and 4,450 tons of TPH. Similarly, Snohomish County Eductor Truck data across different land uses (Snohomish County 1994) would be equivalent to 17 tons of copper, 59 tons of zinc, and 394 tons of TPH. Thus, while the analysis described above is somewhat rudimentary, it does illustrate the utility of preventing stormwater particulates from reaching receiving water where there is a potential for resuspension into the water column.

TSS is not a significant component of aquatic toxicity associated with stormwater (for example, Ecology has not adopted a standard for TSS, instead regulating turbidity as the adverse effect of suspended solids in aquatic systems). However, pollutants associated with solids—heavy metals and PAHs—are chemicals of concern in stormwater that are associated with degradation and impairment of Puget Sound aquatic habitats. Suspended solids in stormwater are associated with both heavy metals and PAHs. As indicated by the Ecology and Snohomish County work described in the previous paragraph, removing suspended solids will, at a minimum, remove solid-associated pollutants including adsorbed metals and PAHs.

6.2.3 PRIORITIZING RETROFIT INVESTMENTS IN THE PUGET SOUND BASIN

Depending on the amount of impervious surface that is selected for retrofit, investments will be large or larger as the preceding analysis demonstrated, which makes a prioritization method important to achieve the maximum pollutant load reduction for the investment.

Today, Phase I permittees are required to have a retrofit plan (S.5.C.6) based on considerations contained in the permit, but no level of funding is required. It is up to the jurisdiction to determine what it can afford and what constitutes a retrofit. Phase II permittees are not required to develop a retrofit plan.

Both Phase I and Phase II permittees have requirements for new development and redevelopment, including roads, which require application of the standards contained in the Ecology 2005 Stormwater Management Manual for Western Washington when certain thresholds of new impervious surface development are met. Redevelopment has historically occurred at 1 to 2 percent per year. Many projects do not create sufficient new impervious surface to meet the threshold for a retrofit, especially projects such as road resurfacing and bridge and culvert replacements. Focus on new development and redevelopment, while important, cannot protect or restore the Puget Sound basin, only slow the level of decline (Booth et al. 2008). If we are to make significant progress by 2020 on the recovery of Puget Sound, accelerating actions to retrofit existing development may be necessary. Given the $8 billion investment that is estimated to retrofit all pre-1996 development greater than 50 percent impervious, investments will need to be prioritized to the highest need.

The EPA MS4 Permit Improvement Guide, April 2010, contains the following guidance on prioritizing retrofits:

Inventory areas and consider as a minimum:

- Locations that contribute pollutants of concern to an impaired water body
- Locations that contribute to receiving waters that are significantly eroded
- Locations that are tributary to a sensitive ecosystem or protected area
- Locations that are tributary to areas prone to flooding
- Locations that are proven heavy contributors of pollutants such as parking lots and high congestion roadways

Then rank the inventoried locations based on at a minimum:

- Feasibility
- Cost effectiveness
- Pollutant removal effectiveness
- Impervious area potentially treated
- Maintenance requirements
- Landowner cooperation
- Neighborhood acceptance
- Aesthetic qualities
- Efficacy at addressing concern
- Proximity to water body

Even though the Kitsap County PIC program priorities are to guide source control investigations, they could be equally applied to prioritize retrofits inasmuch as they match the EPA inventory guidance well.

Prioritization criteria for the Kitsap County PIC program are as follows:

1. An Ecology TMDL is pending or approved.
2. Water body is listed for fecal coliform bacteria on Ecology's most recent Clean Water Action Section 303(d) list of impaired surface waters.
3. The area has been determined to be impaired for commercial and/or recreational shellfish harvest by the Washington State Department of Health and/or the Health District.
4. The Health District has declared the area to be a "Marine Recovery Area" pursuant to RCW 70.118A.040 "Local Health Officers – Determination of marine recovery areas."
5. The Health District has issued a Health Advisory.
6. The Health District monitoring data indicate that the area does not meet Washington State water quality standards.
7. Volunteer monitoring data collected pursuant to Ecology or Health District-approved Quality Assurance Project Plan indicates that the area does not meet Washington State water quality standards.
8. A lake is classified mesotrophic, meso-eutrophic, eutrophic, or hyper-eutrophic either by the Health District or Ecology.

9. The Health District has declared it to be an “OSS Area of Concern” for long-term functionality of on-site sewage systems.

The Puget Sound Watershed Characterization Project: Description of Methods, Models and Analysis (Review Draft, March 2010) contains a methodology for identifying areas "… important to protect, a high priority to restore, and less sensitive to impacts from new development and changes in land use…" but does not yet reach to a "site" scale. However, this work shows great promise when complete for identifying regional and subregional areas where retrofits could be further evaluated for the highest impact on Puget Sound basin recovery.

WRIA plans, though not complete for comprehensive water resources or stormwater planning, already contain priorities for salmonid habitat recovery, and could inform retrofit priority needs.

Two studies are in progress and address the prioritization of retrofits and other BMPs on a watershed scale. The Juanita Creek Basin Retrofitting Analysis Project was funded in 2008 by Ecology. To quote from the project description:

> The Juanita Creek basin, like many other urbanized stream basins in the Puget Sound region, was substantially developed prior to regulations requiring the kinds of stormwater flow control and water quality treatment facilities now required on new developments. As a result, the creek's beneficial uses (particularly salmon use) and water quality have become significantly degraded due to unmitigated increases in stormwater runoff and pollution.
>
> To retrofit already developed areas with modern stormwater facilities is expensive and may not be physically feasible in many areas. Therefore, the use of facilities together with other technologies and strategies, including LID, increased source control, and active treatment systems, need to be evaluated basin wide to determine their costs and effectiveness in reducing stormwater impacts to beneficial uses and achieving compliance with water quality standards. This cost and effectiveness information is essential to securing funding needed for retrofit projects as they compete with other types of projects for scarce capital funds.

It is fortunate that this project is expected to produce some preliminary data in 2010. The final report is expected in 2011.

Another important study funded in 2010 by EPA will address retrofits in the highly urbanized Green/Duwamish River and Central Puget Sound watershed. The abstract for this study states: "The project will develop a cost estimate and prioritization plan for systematically implementing stormwater BMPs and LID techniques in previously developed areas of WRIA 9."

Task 9 of this project is a WRIA 9 watershed retrofit plan; Task 10 is an extrapolation of these data to make a planning level cost estimate for the Puget Sound region. Both tasks are to be completed in late 2013. These studies will allow for a greatly improved estimate of retrofit costs for the Puget Sound basin than the coarse estimate provided by the authors in Task 1 of this report.

Should EPA again fund the CWA 208 program (Puget Sound Action Agenda, 2009), these plans would be the ultimate in prioritizing investments in funding for urban stormwater as well as other pollutant inputs to the Puget Sound basin from non-point sources and point sources alike. Such comprehensive pollution abatement plans could also build political momentum required to make needed policy and regulatory changes. However, such watershed planning takes time and resources as yet unidentified.

7. NPDES PERMIT PROGRAM FUNDING GAPS

Dedicated local stormwater funding in the State of Washington began in the mid-1960s based on Revised Code of Washington (RCW) 35.67 providing the authority to create drainage utilities. Drainage utility rates are generally based on contribution to flooding from the amount of impervious surface of a specific property. It was not until 1995 with the issuance of the first Phase I NPDES permits that a significant amount of local drainage utility funding was directed to water pollution abatement. Today, permittees report that 50 to 80 percent of their drainage utility budget is used for NPDES permit implementation. In 2009, an estimated $160 to $170 million was spent by local jurisdictions on NPDES implementation. This amount is anticipated to increase with the re-issuance of the permits in 2012.

Drainage utilities are well suited for managing small urban streams, lakes, and wetlands because the impacts of impervious surfaces are well studied and readily apparent. However, considering that the total amount of impervious surface in the Puget Sound basin is less than 5 percent currently, there may be a practical limit to how much funding can be raised by drainage utilities, because the basis for utility fees is generally tied to lot imperviousness.

Interviewed permittees acknowledge the value of the NPDES permit program as a significant driver in reducing pollutant loadings from urban stormwater. Most permittees interviewed voiced a concern about being able to continue to adequately fund the existing NPDES permit program given the current state of the economy and their budgets.

Moreover, many are concerned about possible ramping up of the program as it evolves, requiring a higher level of investment than they can afford, particularly for monitoring.

7.1 ECOLOGY FUNDING FOR STORMWATER (2006 – 2011)

The State of Washington has provided some assistance to permittees in a variety of programs.

7.1.1 Capacity Funding for (primarily) NPDES permittees to implement permits

FY 2006 – Total $2.7 Million

- $75,000 each to financially distressed Phase II permittees
- Western Washington, Puget Sound: 10 Phase II permittees [$750,000]
- Western Washington, Non-Puget Sound: 8 Phase II permittees [$600,000]
- Plus 3 secondary permittees and one Phase I permittee
- Eastern Washington, 17 Phase II permittees [$1.3 million]

2007-2009 Total: $8.3 Million [$1.1 million Eastern Washington; $6.86 million Western Washington]

- $75,000 each
- Western Washington, Puget Sound: 69 Phase II permittees, plus 15 Puget Sound Shellfish Districts, Port of Seattle, and 5 Phase I permittees.
- Western Washington, Non-Puget Sound: one Phase I permittee
- Eastern Washington: 10 Phase II permitteess and 3 secondary permittees

2009-2011 [http://www.ecy.wa.gov/programs/wq/stormwater/municipal/MuniStrmwtr Funding.html]

FY 2010 Total: $5.4 Million

- $50,000 each for Phase II permittees (108)

FY 2010-2011 Grants of Regional or Statewide Significance

- $3 million for grants to assist in implementing NPDES municipal stormwater permits

FY 2011 (currently being disbursed) $23,510,000

- $70,000 base for each Phase I and Phase II permittee plus additional funding based on population. Funding amount for each local government posted by July 2, 2010 [http://www.ecy.wa.gov/programs/wq/funding/FundingPrograms/OtherFundingPrograms/StWa12/FY12StWa.html]

7.1.2 Funding for Stormwater Retrofits and LID Projects

FY 2007 - $2.5 million LID grants in Puget Sound basin

FY 2008 - $20.92 million for stormwater-related projects:

- $17.92 million for Puget Sound stormwater projects
- $3 million for non-Puget Sound stormwater projects

FY 2010:

- Centennial Clean Water Funds Stormwater projects: $1 million
- Puget Sound stormwater retrofits and LID construction projects: $3.44 million
- Non-Puget Sound stormwater retrofit and LID construction projects: $860,000

FY 2011-Total $23,447,000 (not yet disbursed)

- Ecology application period – July 1, 2010 to August 31, 2010
- Project list by December 31, 2010
- No specific division as yet for Puget Sound vs. Non-Puget Sound

(Source: Ecology communication: June 28, 2010)

While these grants are helpful, they cover less than 6 percent on average of the Phase II current annual funding needed. Most of the permittees supported state legislation during the past two sessions for a long-term source of funding for stormwater NPDES permit programs with the expectation that some of the funds would be used to assist local NPDES program implementation. While a long-term source of permanent funding was not achieved, the legislature did approve $54 million in one-time funding during the last session, which went to local governments for improved stormwater controls.

7.2 RANGE OF POTENTIAL ACCELERATED NPDES PERMIT PROGRAM COSTS

All Phase II permittees interviewed anticipate that the next NPDES permit cycle will increase their funding need substantially, but other than the projected monitoring increase, these costs are unknown until the next permit cycle begins in 2012. Given the state of most local jurisdictional budget, increases in compliance requirements tend to have the effect of cutting essential core drainage services, which increase risks to public health and safety when flood-related maintenance needs go unaddressed.

However, if the rough cost estimates to accelerate and assess pollutant load reduction outcomes over the next 5 years of the program were summed, they would yield the following Puget Sound basinwide annual revenue need:

Legacy Loads/Removal of Contaminated Sediments	$60 to $120 million
Source Controls	$11 to 18 million
Monitoring	$9 to 15 million
TOTAL	$80 to $153 million

Range of Potential Retrofit Costs

Range of Imperviousness Addressed	80-100%	50-100%	20-100%	0-100%
Acres with Impervious Area Addressed	60,206	162,201	282,663	319,409
Potential Capital Investment *(Average of Low and High Estimate in Appendix A, Table 12)*	$3,010M	$8,110M	$14,133M	$15,645M
Potential Annual Maintenance Investment *(Average of Low and High Estimate in Appendix A, Table 1-2)*	$111M	$300M	$523M	$561M

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APPENDIX A

Puget Sound Stormwater Retrofit Cost Estimate